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SPACE AND SCIENCE.

COMMON sense conceives space as a condition or *prius* of things. This table fills a space, and I can abstract the table, but not the space. It is a common jest that a man cannot crawl into a hole and pull the hole in after him. Suppose that I can exhaust everything, even the slightest particle of gas, from a receiver, and leave nothing there; I cannot remove the 'there,' the particular space which always remains ready for anything I may choose to put in it. Things are commonly thought to be alterable and destructible, spaces unalterable and indestructible. Of course, this conception includes space as the sum of spaces.

Mathematics, as a science of space, refines and rationalizes the common-sense conception of space. Thus a point, which is commonly regarded as a very minute surface, is for mathematics a mere position; and a line, which is commonly conceived as a very narrow strip, is mathematically mere length without breadth. Common sense sees in spaces only the outlines, dimensions, and tracks of things, and space in general is merely room. But mathematics sets aside the influence of the thing, and develops a science of pure space. It is interesting to note, however, that mathematics is not thereby isolated from reality as scientifically understood by methods far deeper than common sense. Physics may illustrate the most abstract mathematics. Thus, Abelian integrals can "best be understood and illustrated by considering electric currents on closed surfaces."[1] Pure mathematics deduces an indefinite number of space-worlds, as in forms of four and higher dimensioned space, which are entirely transcendental. However, though manifold space could never have been deduced from the behavior of things, yet, once ideally deduced, the mathematician can deduce also how the thing would behave in such space, as, for instance, the untying of knots. We cannot deny the possible actuality of these forms of space, and their significance for physical values.

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[1] Klein, *Lectures on Mathematics*, p. 46.

In passing, we may ask whether a development of transcendental time, corresponding to that of transcendental space, is possible. Certainly time, as space for events, has much in common with space for things; and in transcendental time we might expect an event to happen both before and after another event. A science of pure time carried out on the same lines as that of pure space would be highly interesting.

If mathematics refines the objectivity of space to its most general and abstract form, psychology emphasizes its subjectivity. The spatializing is of eminent service in the struggle of existence, and appears very early. Localization is the simplest and most essential cognition. Adjustment and adaptation imply spatializing to environment. The common-sense conception of space thus becomes vindicated as a life factor. But, though psychology, in tracing the development of space perception as a life factor, sees that its common-sense realism is only a rough and ready, hit and miss method, and not a scientific study and adaptation, a closer and more accurate survey refines and enlarges our conceptions. Psychology may even point out that self-contained and absolute experience would not need to spatialize, space being an appearance and finite function. Common sense is only makeshift experience, and so its generalization, that space is an inert bare form for containing things, is an unlikely hypothesis. In fact, science, as uncommon sense, may assume it as a maxim that common sense is always imperfect and wrong. Psychology itself must trace the conception of space far beyond the crude appearance given in the struggle of existence, and into the highest conceptions of science.

But if we seek the most satisfactory understanding of space, we shall look neither to mathematics nor to psychology, but to physics. The trend of physics, say with such a representative as Ostwald, is to make things the expression of force; the constitution and appearance of the thing is determined by dynamism; and we may best interpret space as a mode of this dynamic appearance. Physics views everything in the universe as holding its own against all other bodies by its own forcefulness, and we regard space as the appearance of this repulsiveness. It is obvious that if things were mutually penetrable, the appearance of space would disappear. To common observation, indeed, the table is an inert body occupying an inert space; but physical science assures us that the table is holding its own against gravity, the action of air, etc. The table standing in the hall is, by its inherent, coherent dynamism, supplanting air, and so making a spaceful show of itself. Space, then, is not full of things, but things are spaceful. And space as quantity of appearance, and time as its continuance, are obviously aspects and measures of the force of the thing. Other things being equal, the more space and time a thing as center of force shows, the more force it has. The physical theory of energy, and Newton's third law of motion, clearly point to space as a form of dynamic appearance.

We have sought to make clear that the most rational scientific theory of space is that it is appearance produced by the individual dynamic repulsiveness by which, according to physics, the thing consists and exists. Everything does not, as commonly conceived, fall into some pre-existent space convenient for it, but everything makes its own spaciousness by its own defensive and offensive force, and the totality of all appearances is space in general. If it be said that the table occupies a space which existed before the table existed, and will exist ever after as a certain definite space, which always remains awaiting anything that can appropriate it, we answer that the table-space ceases to exist with the table, and other spaces are created. That is, the thing always measures the space. We define the space by the thing. If we abstract the thing, we leave the lines of the thing as the table, so that the space is a ghost of the thing. Space always implies boundary or forms given by things. Hence, also, space is always a particularity, a here and a there, position and form alike being determined by the thing. And so when Mr. Bradley says, "Space is a relation between terms which never can be found,"[1] we see only a double tautology, 'terms' and 'found' both implying spatiality.

We notice, further, that physics does not find void space as an existence; dynamism permeates and dominates all actuality.

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[1] 'Appearance and Reality,' p. 38.

But suppose that we could entirely exhaust the receiver, we then should have a patch of nothing walled in and determined by environment, in short a temporary hole in the universe. And if the universe were swept away, the hole also would disappear, there being nothing to reckon it from. In conceiving all things annihilated, we say we have space left; but what is this space? Only the places of things or directions and distances therefrom—that is, the appearance of quantity which things have made for themselves, or imaginary duplications thereof. And the conservation of energy means that we cannot blot out a single thing in order to secure its place; we can only set up dynamic relations which are supplanting, and give the appearance we call displacing. The mutually exclusive nature of dynamism gives the space effect. Why natural forces act in this warring manner, we know not; but it is plain that if forces, as constitutive of things, were inclusive, were mutually penetrative, the space effect would disappear, the table would not stand out against other objects as having a place of its own. Physics passes into metaphysics in making the primal fact of physical reality a general dynamism, of which ether, atom, molecule, and all things are expressions. Thus, substance, space, and time, become appearances of this primal fact. And, of course, substance, space, and time, increase and decrease with dynamism of which they are manifestations.

The dynamic theory carries us beyond the common dualism of space and thing, the belief that space first existed, and then things were put in it. So monism from the side of space does not save us, for space as the great inactive, as absolute inertia, can give rise to nothing. We must then find space as involved in things by virtue of the mutual exclusiveness and opposition of the forces which constitute things.

This dynamistic theory relieves us also from the difficulties of a subjective theory of space, like the Kantian, which makes a dualism of knowledge and reality. Space is not a mere epistemological form, but, like color, a real appearance, founded in the nature of physical reality as being opposing forces in a general struggle of existence. Of course the physical theory of space destroys the Kantian apriorism and necessity. And as mathematics advances into physics and *vice versa*, we see both mathematics losing in absoluteness, and physics gaining. We mean that mathematics and physics are essentially on the same plane, and mutually interpretative. Certainly the tentativeness of mathematics as science of space is just now what is most strongly felt by the most advanced mathematicians.[1] Klein asserts that "our geometrical demonstrations have no absolute objective truth, but are true only for the present state of our knowledge. These demonstrations are always confined within the range of the space-conceptions that are familiar to us ; and we can never tell whether an enlarged conception may not lead to further possibilities that would have to be taken into account. From this point of view we are led in geometry to a certain modesty, such as is always in place in the physical sciences." It was Kant's dogmatic subjective apriorism that led him in the Transcendental Æsthetic to mention space of more than three dimensions as an absurdity worthy of no consideration ; and yet we now know that Non-Euclidean Geometry is a most brilliant department of mathematics, and promises important physical applications. It will be strange, indeed, if physical reality exhibits itself only in the dimensions which common sense has sanctioned.

That space is a *prius* of things, is commonly inferred from the fact that we easily conceive thingless space, but not spaceless thing. Yet space is always capacity for thing, as thing is always capacity for space. The conception of thingless space has been gained by common sense in a mere practical and unscientific manner, as when a room without furniture is accounted empty, though physical science must account it full. If the air did not make the room, the room would disappear. A certain form of spacelessness is attained by so-called 'annihilating.' Since our perception of space is according to the time taken in traversing it, if the swiftness is so great that the time is unappreciable, the space is unappreciable. Psychologically speaking, the earth is much smaller to us than to our ancestors ; though since our sense of time has become much more sensitive, the decrease is not what it would otherwise be. However, we can conceive a being who, by the swiftness of his movements, and the dullness of his sense of time, would be without sense of space. But such spacelessness would, of course, be not metaphysical, but merely psychological, though of interest in illustrating how a conception is bred of practical experience, rather than of scientific research. The common-sense conception of space as a form eternally existent, and ready for the relation of things, is plainly the outcome of an imperfect unscientific experience. Space is the ghost of real things, and came naturally to be taken for a real thing in itself.

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[1] *vide.* Klein, *Lectures on Mathematics*, p. 93.

To inquire into the extent of space, whether finite or infinite, may seem to be the idle query as to the spaciousness of space, an attempt to measure a thing by itself. But if space is a mode of actuality due to dynamism, we may rightly suppose that infinite dynamism will display infinite spatiality. Yet, as we define space as the appearance of mutually opposing dynamisms, space must at least be dual, and so not strictly infinite. The indefinite separativeness into things shows as an indefinite amount of spatialization as a totality. Space, strictly speaking, is a phenomenon in the multiplex antagonistic relativity of indefinite, or if you speculatively please, of infinite force. Thus it may be said to be finite on an infinite scale; and this suggests a solution of the antinomy of finite and infinite space. While space is really only a phenomenon of the inner and finite life of the infinite, yet, as a general mode of the activity of the whole, it may be termed infinite. The evolution of things as separate, yet related centers of force, in short the whole evolution of the finite, as considered as a self-process of the infinite, may be called infinite, though the actuality of thing, space, and time is only finite. And space itself can never be either too big or too little for things, but is merely their manifestation, as they express the separativeness of force-centers holding their own in the evolution of being.

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